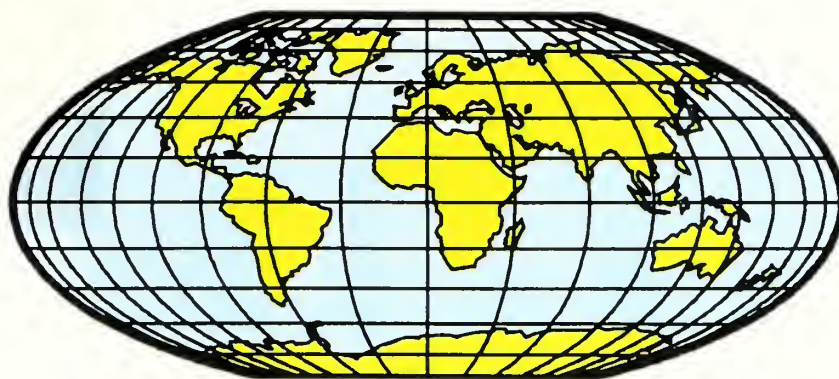


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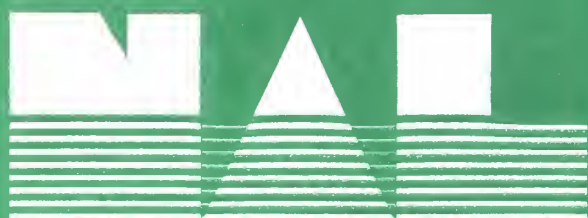


Popular Diets: A Scientific Review

Prepared for
United States Department of Agriculture
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Executive Summary

Introduction

Weight loss is a major concern for the US population. Surveys consistently show that most adults are trying to lose or maintain weight (Serdula, 1999). Nevertheless, the prevalence of overweight and obesity has increased steadily over the past 30 years. Currently, 50% of all adult Americans are considered overweight or obese (Flegal, 1998; Mokdad, 1999). These numbers have serious public health implications. Excess weight is associated with increased mortality (Allison, 1999), and morbidity (Must, 1999). It is associated with cardiovascular disease, type 2 diabetes, hypertension, stroke, gallbladder disease, osteoarthritis, sleep apnea and respiratory problems, and some types of cancer (NHLBI, 1998; WHO, 1998).

Most people who are trying to lose weight are not using the recommended combination of reducing caloric intake and increasing physical activity (Serdula). Although over 70% of persons reported using each of the following strategies at least once in four years: increased exercise (82.2%), decreased fat intake (78.7%), reduced food amount (78.2%), and reduced calories (73.2%), the duration of any one of these behaviors was brief. Even the most common behaviors were used only 20% of the time (French, 1999).

Obesity-related conditions are significantly improved with modest weight loss of 5% to 10%, even when many patients remain considerably overweight (NHLBI, 1998). The Institute of Medicine (1995) defined successful long-term weight loss as a 5% reduction in initial body weight (IBW) that is maintained for at least one year. Yet, data suggest that such losses are not consistent with patients' goals and expectations. Foster (1997) reported that in obese women (mean BMI of 36.3 ± 4.3) goal weights targeted, on average, a 32% reduction in IBW, implying expectations that are unrealistic for even the best available treatments. Interestingly, the most important factors that influenced the selection of goal weights were appearance and physical comfort rather than change in medical condition or weight suggested by a doctor or health care professional. Is it any wonder that overweight individuals are willing to try just about any new diet that promises quick, dramatic results more in line with their desired goals and expectations than with what good science supports?

The proliferation of diet books is nothing short of phenomenal. A search of books on Amazon.com using the key words "weight loss" revealed 1,214 matches. Of the top 50 best selling diet books, 58% were published in 1999 or 2000 and 88% were published since 1997. Many of the top 20 best sellers promote some form of carbohydrate restriction (e.g. Dr. Atkins' New Diet Revolution, The Carbohydrate Addict's Diet, Protein Power, Lauri's Low-Carb Cookbook) (Amazon.com, 8/26/00).

What is really known about popular diets? Is the information scientifically sound? Are popular diets effective for weight loss and/or weight maintenance? What is the effect, if any, on composition of weight loss (fat versus lean body mass), micronutrient (vitamin and mineral) status, metabolic parameters (e.g. blood glucose, insulin sensitivity, blood pressure, lipid levels, uric acid, and ketone bodies)? Do they affect hunger and appetite, psychological wellbeing, and reduction of risk for chronic disease

(e.g. coronary heart disease, diabetes, and osteoporosis)? What are the effects of these diets on insulin and leptin, long-term hormonal regulators of energy intake and expenditure?

The objective of this paper is to review the scientific literature on various types of popular diets based on their macronutrient composition in an attempt to answer these questions (see **Appendix I** for diet summaries).

Evidence Based Guidelines

This paper is limited to the effects of popular diets in overweight and obese adults; there are no good data on children and adolescents. Dietary claims are scrutinized, diets are analyzed, and information is compared to scientific data published in peer reviewed journals. No published studies are excluded, despite inherent methodological problems (e.g. small or inadequate sample size, limited duration, lack of adequate controls and randomization, poor or minimal dietary collection and/or description of diets, and potential biases). However, the strength of the evidence supporting various conclusions made throughout the paper is based on the following grading system used by NHLBI (1998) (**Table 1**).

Table 1. Grading System and Evidence Categories

Evidence Category	Sources of Evidence	Definition
A	Randomized controlled trials (RCTs) (rich body of data)	Evidence is from endpoints of well-designed RCTs (or trials that depart only minimally from randomization) that provide a consistent pattern of findings in the population for which the recommendation is made.
B	Randomized controlled trials (limited body of data)	Evidence is from endpoints of intervention studies that include only a limited number of RCTs, post hoc or subgroup analysis of RCTs, or meta-analysis of RCTs. In general, Category B pertains when few randomized trials exist, they are small in size, and the trial results are somewhat inconsistent.
C	Nonrandomized trials Observational studies	Evidence is from outcomes of uncontrolled or nonrandomized trials or from observational studies.

Characterization of Diets

Diets are characterized below and in **Tables 2 and 3**. The defining characteristic(s) is bolded.

- **High-fat (55 – 65%), low-carbohydrate (< 100 g CHO/day)**, high protein diets (e.g. Dr. Atkins' New Diet Revolution; Protein Power; Life Without Bread).
- **Moderate-fat (20 – 30% fat) reduction diets**, high in carbohydrate and moderate in protein (e.g. USDA Food Guide Pyramid, DASH diet, Weight Watchers)
- **Low-fat (11 – 19%), and very-low-fat (<10)**, very-high-carbohydrate, moderate-protein diets (e.g. Dr. Dean Ornish's Program for Reversing Heart Disease; Eat More, Weigh Less; The New Pritikin Program)

Table 2. Characterization of Diets as Percentage of Calories

Type of Diet	Fat % kcals	Carbohydrate % kcals	Protein % kcals
High-fat, low-carbohydrate	55 – 65	< 20% (< 100 g)	25 – 30
Moderate-fat	20 – 30	55 – 60	15 – 20
Low- and very-low-fat	< 10 – 19	> 65	10 – 20

Table 3. Characterization of Diets in Absolute Amounts (grams)

Type of Diet	Total kcals	Fat g (%)	Carbohydrate g (%)	Protein g (%)
Typical American	2,200	85 (35)	275 (50)	82.5 (15)
High-fat, low-carbohydrate	1,414 ¹	96 (60)	35 (10)	105 (30)
Moderate-fat	1,450	40 (25)	218 (60)	54 (15)
Low- and very-low-fat	1,450	16 – 24 (10 – 15)	235 – 271 (65 – 75)	54 – 72 (15 – 20)

¹ Based on average intake of subjects who self-selected low-CHO diets; studies lasting more than one week (e.g. Evans, Yudkin, Larosa. See Table 4).

Summary of Findings

A. *Weight Loss*

Diets that reduce caloric intake result in weight loss. In the absence of physical activity, a diet that contains about 1,400 – 1,500 kcal/day, regardless of macronutrient composition, results in weight loss. Individuals consuming high-fat, low-CHO diets may lose weight because the intake of protein and fat is self-limiting and overall caloric intake is decreased (Yudkin, 1960; Evans, 1974). Low-fat and very-low-fat diets contain a high proportion of complex carbohydrates, fruits, and vegetables. They are naturally high in fiber and low in caloric density. Individuals consuming these types of diets consume fewer calories and lose weight (Ornish, 1993, 1998a; Pritikin, 1990, 1999, 2000). Moderate fat reduction diets contain moderate amounts of carbohydrate and protein. When overall caloric intake is reduced, these diets result in loss of body weight and body fat (NHLBI, Shape Up America!). Importantly, moderate-fat reduction diets produce weight loss even when they are consumed *ad libitum*.

In sum, all popular diets, as well as diets recommended by governmental and non-governmental organizations, result in weight loss. However, it is important to note that weight loss is not the same as weight maintenance.

Evidence Statement: Caloric balance is the major determinant of weight loss. Diets that reduce caloric intake result in weight loss. In the absence of physical activity, the optimal diet for weight loss contains about 1,400 – 1,500 kcal/day, regardless of macronutrient composition. Evidence Category A.

Evidence Statement: Free-living overweight individuals who self-select high-fat, low-CHO diets consume fewer calories and lose weight. Evidence Category C.

Evidence Statement: Overweight individuals consuming high-fat, low-CHO, low-calorie diets under experimental conditions lose weight. Evidence Category C.

Evidence Statement: Overweight individuals consuming moderate-fat reduction diets lose weight because they consume fewer calories. These diets can produce weight loss when consumed *ad libitum*. Evidence Category A.

Evidence Statement: Overweight individuals consuming low- and very-low-fat diets lose weight because they consume fewer calories. Evidence Category B.

Evidence Statement: Weight loss on very-low-fat diets may be the result of lifestyle modification, which may include decreased fat and energy intake, increased energy expenditure, or both. Evidence Category B.

B. *Body Composition*

As body weight decreases, so does body fat and lean body mass. The optimal diet for weight loss is one that maximizes loss of body fat and minimizes loss of lean body mass. All low-calorie diets result in loss of body weight and body fat (NHLBI). Macronutrient composition does not appear to play a major role (Kinsell, 1964; Powell, 1994; Golay, 1996). In the short-term, however, low-CHO ketogenic diets cause a greater loss of body water than body fat (Yang, 1976). When these diets end, water weight is regained (Kekwick, 1957). Eventually, however, all reduced calorie diets result in loss of body fat if sustained long-term (van Itallie, 1975).

Physical activity, an important factor with respect to lean body mass, should be promoted to enhance the effects of diet on body composition.

Evidence Statement: All low-calorie diets result in loss of body weight and body fat. Macronutrient composition does not appear to play a major role. Evidence Category A.

Evidence Statement: In the short-term, low-CHO ketogenic diets cause a greater loss of body water than body fat. Water weight is regained when the diet ends. If the diet is maintained long-term, it results in loss of body fat. Evidence Category C.

C. *Nutritional Adequacy*

Proper food choices are always important when considering the nutritional quality of a diet. When individuals consume foods from all food groups, it is more likely that their diet will be nutritionally adequate. The moderate-fat reduction diet is optimal for ensuring adequate nutritional intake. However, poor food choices may result in inadequate levels of nutrients (e.g. calcium, iron, zinc), regardless of overall macronutrient composition. High-fat, low-carbohydrate diets are nutritionally inadequate. They are low in vitamins E, A, thiamin, B₆, folate, calcium, magnesium, iron, zinc, potassium, and dietary fiber, and require supplementation. These diets are high in saturated fat and cholesterol. Very-low-fat diets are deficient in vitamin B₁₂ because meat intake is low.

Evidence Statement: The moderate-fat reduction diet is nutritionally adequate. Evidence Category A.

Evidence Statement: High-fat, low-carbohydrate diets are nutritionally inadequate, and require supplementation. Evidence Category C.

Evidence Statement: Very-low-fat diets are deficient in Vitamin E, B₁₂, and zinc. Evidence Category B.

D. *Metabolic Parameters*

Low-CHO diets result in ketosis, and may cause a significant increase in blood uric acid concentrations.

Blood lipid levels (e.g. total cholesterol, LDL, HDL and triglycerides) decrease as body weight decreases (Dattilo, 1992; Yu-Poth, 1999; NHLBI). However, the macronutrient and fatty acid composition of energy-restricted diets can exert substantial effects on blood lipids. There are significantly greater decreases in LDL cholesterol during active weight loss when diets are low in saturated fatty acids. Changes in HDL cholesterol depends on the fat content of the diet and the duration of energy restriction (Noakes, 2000).

Plasma triglyceride levels also decrease with weight loss (NHLBI). Although they increase in response to short-term consumption of a very-low-fat, high-carbohydrate diet (Lichtenstein), the type of carbohydrate consumed must be considered. High fiber foods, including vegetables and legumes do not lead to hypertiglyceridemia (Anderson, 1980), and may easily be incorporated into all moderate-fat reduction diets.

Energy restriction, independent of diet composition, improves glycemic control (Grey, 1971; Golay, 1996; Baba, 1999; Heilbron, 1999). As body weight decreases, so does blood insulin and plasma leptin levels (Golay, Havel, 1996).

Blood pressure decreases with weight loss, independent of diet composition (Golay, Dattilo, NHLBI). However, the DASH diet, high in fruits, vegetables, and low-fat dairy products effectively lowers blood pressure (Appel, 1997).

Evidence Statement: High-fat, low-CHO diets result in ketosis. Evidence Category B.

Evidence Statement: Metabolic profiles are improved with energy restriction and weight loss. Evidence Category A.

Evidence Statement: Low-CHO diets that result in weight loss may also result in decreased blood lipid levels, decreased blood glucose and insulin levels, and decreased blood pressure. Evidence Category C.

Evidence Statement: Low- and very-fat diets reduce LDL-cholesterol, and may also decrease plasma triglyceride levels, depending on diet composition. Evidence Category B.

Evidence Statement: Moderate-fat, balanced nutrient reduction diets reduce LDL-cholesterol, normalize plasma triglycerides, and normalize the ratio of HDL/total cholesterol. Evidence Category A.

E. Hunger and improve compliance

Many factors influence hunger, appetite, and subsequent food intake. Macronutrient content of the diet is one, and it may not be the most important. Neurochemical factors (e.g. serotonin, endorphins, dopamine, hypothalamic neuropeptide transmitters), gastric signals (e.g. peptides, stomach distention), hedonistic qualities of food (e.g. taste, texture, smell), genetic, environmental (e.g. food availability, cost, cultural norms) and emotional factors (e.g. eating when bored, depressed, stressed, happy) must be considered. These parameters influence appetite primarily on a meal-to-meal basis. However long-term body weight regulation appears to be controlled by hormonal signals from the endocrine pancreas and adipose tissue, i.e., insulin and leptin. Since insulin secretion and leptin production are influenced by the macronutrient content of the diet (Havel, 1999; Romon, 1999), effects of different diets on these long-term regulators of energy balance also need to be considered when investigating hunger and appetite.

All fat-restricted diets provide a high degree of satiety. Subjects who consume fat-restricted diets do not complain of hunger, but of having "too much food" (Schaefer, 1995; Siggaard, 1996). These diets, high in fiber and water content are low in caloric density. Subjects who consume these diets develop a distaste for fat (Harvey-Berino, 1998), which may be useful in long-term adherence to reduced fat, low-calorie diets. However, it is not clear that restricting fat provides any advantage over restricting carbohydrates. Ogden (2000) reported weight loss maintainers used healthy eating habits and adhered to calorie-controlled diets.

Long-term compliance to any diet means that short-term weight-loss has a chance to become long-term weight maintenance (Bray, 1998; Astrup, 2000; Hill, 2000). Dietary compliance is likely a function of psychological issues (e.g. frequency of dietary counseling, coping with emotional eating, group support) rather than macronutrient composition, *per se* (Alford, 1990; Bray, 1998). Being conscious of one's behaviors, using social support, confronting problems directly, and using personally developed strategies may enhance long-term success (Kayman, 1990). Ogden notes that successful weight loss and maintenance may be predicted by an individual's belief system, e.g. that obesity is perceived as a problem which can be modified and if modifications bring changes in the short-term which are valued by the individual concerned.

Evidence Statement: Many factors influence hunger, appetite, and subsequent food intake. There does not appear to be an optimal diet for reducing hunger. Evidence Category B.

Evidence Statement: Long-term compliance is likely a function of psychological issues rather than macronutrient composition, *per se*. Evidence Category B.

SUMMARY AND RECOMMENDATIONS

Caloric balance (calories in vs. calories out), rather than macronutrient composition is the major determinant of weight loss. However, what is not clear is the effect of macronutrient content on long-term weight maintenance and adherence. Furthermore, it is not known whether maintenance of weight loss and dietary adherence is related to psychological issues (and brain neurochemistry), physiological parameters (e.g. hormones involved in body weight regulation such as insulin and leptin), physical activity, energy density, or some other factor(s).

Controlled clinical trials of high-fat, low-CHO and low- and very-low-fat diets are needed to answer questions regarding long-term effectiveness (e.g. weight maintenance rather than weight loss) and potential long-term health benefits and/or detriments.

Prevention of weight gain and weight maintenance is an important goal. Scientifically validated, yet understandable information is clearly needed by millions of overweight and obese Americans who often find weight loss attainable, but maintaining weight loss nearly impossible.

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